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Radioactive Iodine as An Indicator in Thyroid Physiology

II. Iodine Collection by Normal and Hyperplastic Thyroids in Rabbits*

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SUMMARY

USING radioactive iodine as an indicator, the quantity of iodine taken up by the thyroid of the rabbit under various circumstances was studied. After intravenous injection, the percentage collection from any given dose was found to reach a maximum within ten minutes, which was not greatly exceeded for periods of collection as long as several days. The normal thyroid was found to collect up to 80 times the quantity to be expected from uniform diffusion into the general body tissues. In hyperplastic thyroids, this relative concentration may reach several hundred. The variation of this concentration with the injected dosage and the functional state of the gland was determined. The effect of pretreatment of the thyroid in various functional states, with iodine, on the collection of a subsequent dose of labelled iodine was measured.

In certain of these experiments, several differently labelled iodine injections were used on the same animal in order to determine the fate of the individual doses. This labelling was accomplished by using different radioactive isotopes.

From the data thus obtained, we have calculated the strength of samples of radioactive iodine with which it will be possible to administer internal irradiation of the thyroid for therapeutic purposes.

Clinical implications of the results are discussed.

INTRODUCTION

In previous papers^{1,2} we have described the technic and advantages of the use of radioactive isotopes of iodine as indicators in the study of iodine distribution and have reported preliminary results obtained with this method. This paper is concerned with the detailed results of extended experiments on normal rabbits and on rabbits which had received previous treatment designed to influence the physiologic state of the thyroid.

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The great majority of the experiments were conducted with the use of the radioactive isotope of iodine of mass 128, which has a half period of 25 minutes. We have also used a few samples of radioactive iodine with the half periods of 12.5 hours, 8 days and 13 days (mass numbers 130, 131, and 126 respectively). Thus most of the experiments have extended over a period usually not greater than one and one-half hours from the time of administration of the radioactive iodine, and a few have been extended for longer periods, up to eight days.

PURPOSE OF EXPERIMENTS

It was the purpose of these experiments to investigate the collection of iodine by normal and hyperplastic thyroid glands, in order to establish the normal and pathological behavior toward iodine under various circumstances, and in order to determine the conditions under which it might be possible to use radioactive iodine to administer internal irradiation of the thyroid. The experiments have therefore been concerned with the measurement of the percentage collection of known doses of labelled iodine by the thyroid, as a function of time of collection, quantity of iodine injected, previous history of iodine treatment, thyrotropic hormone administration, cyanide injection, cabbage diet, sex, pregnancy, and certain combinations of these factors.

PROCEDURES

The iodine was almost invariably administered intravenously in the form of sodium iodide obtained by dissolving labelled silver iodide in sodium thiosulphate. In a few experiments in which long collection times were possible because of the availability of long-period iodine isotopes, subcutaneous injections were made. Animals were sacrificed by etherization, since the available radioactivities necessitated the removal of the thyroid for measurements.

For purposes of comparison, the dosages of iodine administered (except in some preliminary work) were adjusted to be proportional to the weight of the animal, 2 kg. being taken as a standard. Dosages below 0.5 mg. were not so adjusted, however, it being of interest to determine the collection of the smallest available quantities of iodine. The range of dosages used was from less than 0.1 mg. to 100 mg.

Since it was necessary in these experiments to use the entire thyroid for measurement of the iodine collection, it was impossible to make histological sections for the purpose of comparing the degree of stimulation of the different glands, as we should have desired. In some parallel studies of human thyroid glands, these data have been obtained. We hope soon to report the correlation of the data obtained with measurements of the basal metabolic rate on both animals and humans. In the present experiments, in addition to the information given by the gross appearance of the gland, we have used as a rough measure of the physiologic state of the thyroid the relative weight of the thyroid as compared with the body weight. It is well known that this is by no means a completely satisfactory indication of the physio-